

Platinum Recycling Technology Development (New FY 2004 Project)

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Objectives

- Develop technology for the recycling and/or re-manufacture/reuse of catalyst-coated fuel cell membranes and catalyst-coated fuel processing components that are used in fuel cell systems.
- Recover valuable platinum group metals and NAFION™ fluorine-containing polymer.
- Develop comprehensive understanding of the failure mechanisms of fuel cell catalysts and membranes.

Technical Barriers

This project addresses the following technical barriers from the Fuel Cells section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year R,D&D Plan:

- O. Stack Material and Manufacturing Cost
- P. Durability

Approach

The overall objective of this project is to develop technology for the recycling and/or re-manufacture of catalyst-coated fuel cell membranes and catalyst-coated fuel processing components that are used in fuel cell systems. A novel feature of our approach is the recovery of the active ionomer as well as the precious metals. Currently, platinum is the most viable catalyst for proton exchange membrane (PEM) fuel cell systems. However, if the potential of this technology is to be realized, the long-term availability of platinum group metals may become a serious limitation. As platinum reserves are depleted, this will lead to an increase in the cost of fuel cells. Hence, platinum recycling is critical to the long-term economic sustainability of PEM fuel cells. In addition, the value of the ionomer component in catalyst-coated membranes currently exceeds that of the precious metals; thus,

recovery of the ionomer is also warranted. Future cost estimates using projected annual fuel cell vehicle production volumes of 500,000 per year demonstrate that cost of the ionomer will continue to be a major cost contributor to fuel cell power plants relative to the platinum required. Furthermore, it is the presence of the NAFION™ fluorine-containing polymer in the fuel cell recycle stream that greatly complicates conventional recycling methods, which are ill-suited due to the toxic and corrosive HF gas released during these processes. We will therefore develop a process that enables the extraction and reuse of both the precious metals and the ionomer in current fuel cell components.

We will also demonstrate the feasibility of a novel vapor phase extraction process to reclaim precious metals from fuel processing components. We will recover the platinum group metals in an

environmentally benign manner as well as the valuable NAFIONTM.

This project brings together large and small industrial partners with a strong group of university faculty researchers to develop a novel method of recovering all of the valuable materials of PEM fuel cell systems. Ion Power and DuPont have an existing long-term business relationship dedicated to the promotion of the NAFIONTM polymer in all applications. Ion Power, Inc. is a small business working on developing high performance catalyst coated membranes for fuel cell and electrolyzer applications. The faculty members from the Department of Chemical Engineering at the University of Delaware provide world-recognized expertise in the technical areas of vapor phase extraction and deposition of platinum group metals (PGM), characterization and evaluation of PGM electrocatalysts, physical characterization of ionomers, and separation science.

In this project, we propose to develop a process that will allow for the re-manufacture of new catalyst coated membranes (CCMs) from used CCMs extracted from failed fuel cell stacks. This will be accomplished by removing the CCM from the stack, decontaminating the CCM to remove impurities, and then dissolving the CCM in an autoclave reactor to form a slurry of dissolved NAFIONTM together with the Pt/C catalyst particles. We will develop a technology that will then separate these two valuable ingredients and allow the NAFIONTM solution to be re-processed into a new fuel cell membrane. Ideally, the recovered catalyst (Pt/C) will be re-deposited on the re-manufactured membrane so that a completely re-manufactured CCM is the final deliverable. As a result of our multifaceted industrial and academic team, an important byproduct of this project will be fundamental research that will help determine the failure mechanisms that are currently hampering the performance of state-of-the-art catalyst coated membranes.